

WHAT IS CLAIMED IS:

- 1 1. *A driving assist system for assisting effort by an operator*
2 *to operate a vehicle in traveling, the driving assist system*
3 *comprising:*
4 *a data acquisition system acquiring data including*
5 *information on vehicle state and information on environment in*
6 *a field around the vehicle;*
7 *a controller, mounted to the vehicle, for receiving the*
8 *acquired data, for determining future environment in the field*
9 *using the acquired data, for making an operator response plan in*
10 *response to the determined future environment, which plan*
11 *prompts the operator to operating the vehicle in a desired*
12 *manner for the determined future environment, to determine*
13 *command, and for generating the command; and*
14 *at least one actuator, mounted to the vehicle, for*
15 *prompting the operator in response to the command to*
16 *operating the vehicle in the desired manner.*
- 1 2. *The driving assist system as claimed in claim 1, wherein*
2 *the information on environment involves information on the*
3 *presence of obstacles in the field; wherein the determined future*
4 *environment involves a risk which each of the obstacles would*
5 *cause the operator to perceive; and wherein the operator*
6 *response plan is made to prompt the operator to operating the*
7 *vehicle in the desired manner to reduce the risks.*
- 1 3. *The driving assist system as claimed in claim 2, wherein*
2 *the information on environment involves information on road*
3 *condition; wherein the determined future environment involves*
4 *a risk derived from the road condition, which is determined by a*
5 *lateral deviation of the vehicle from a lane and by curvature of*

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6 the lane; and wherein the operator response plan is made to
7 prompt the operator to operating the vehicle in the desired
8 manner to reduce the risks superimposed by the risk derived
9 from the road condition.

1 4. The driving assist system as claimed in claim 1, wherein
2 the operator response plan includes the amount of input to the
3 actuator, and wherein the actuator is capable of modulating
4 reaction characteristic to manual effort by the operator.

1 5. The driving assist system as claimed in claim 1, wherein
2 the information on environment involves information on the
3 presence of a leading vehicle ahead in the same lane on a road in
4 the field.

1 6. The driving assist system as claimed in claim 5, wherein
2 the controller uses information of velocity of the vehicle, velocity
3 of the leading vehicle and relative vehicle velocity in determining
4 future environment in the field.

1 7. The driving assist system as claimed in claim 5, wherein
2 the determined future environment includes a relative positional
3 relation between the vehicles.

1 8. The driving assist system as claimed in claim 6, wherein
2 the determined future environment includes a relative position
3 between the vehicles.

1 9. The driving assist system as claimed in claim 1, wherein
2 the actuator is capable of modulating reaction characteristic to
3 manual steering effort by the operator.

1 10. The driving assist system as claimed in claim 1, wherein

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2 the actuator is capable of modulating reaction characteristic to
3 manual effort applied onto an accelerator of the vehicle by the
4 operator.

1 11. The driving assist system as claimed in claim 1, wherein
2 the actuator is capable of modulating reaction characteristic to
3 manual effort applied onto a brake of the vehicle by the
4 operator.

1 12. A driving assist system for assisting effort by an operator
2 to operate a vehicle in traveling, the driving assist system
3 comprising:
4 a data acquisition system acquiring data including
5 information on vehicle state and information on environment in
6 a field around the vehicle, the information on environment
7 involving information on the presence of obstacles in the field;
8 a controller, mounted to the vehicle, for receiving the
9 acquired data, for determining future environment in the field,
10 the determined future environment involving a risk which each
11 of the obstacles would cause the operator to perceive, for
12 making an operator response plan in response to the determined
13 future environment, which plan prompts the operator to
14 operating the vehicle at least longitudinally to reduce the risks,
15 to determine commands, and for generating the commands;
16 and
17 a plurality of actuators, mounted to the vehicle, for
18 prompting the operator in response to the commands to
19 operating the vehicle at least longitudinally, the plurality of
20 actuators includes an accelerator reaction modulation actuator
21 capable of modulating reaction characteristic to manual effort
22 applied onto an accelerator of the vehicle.

1 13. A driving assist system for assisting effort by an operator

2 to operate a vehicle in traveling, the driving assist system
3 comprising:

4 *a data acquisition system acquiring data involving*
5 *information on the presence of a leading vehicle in a field around*
6 *the vehicle; and*

7 a controller, mounted to the vehicle, for receiving the
8 acquired data, for determining a first extent to which the
9 vehicles has approached to each other and a second extent to
10 which the first extent might be influenced if a change in
11 environment should occur, and for determining future
12 environment in the field based on the first and second extents.

14. The driving assist system as claimed in claim 13, wherein, in determining the first and second extents, the controller uses a velocity of the vehicle, a velocity of the leading vehicle, and the vehicle separation.

15. The driving assist system as claimed in claim 14, wherein
the first extent is a first risk category, and the second extent is a
second risk category.

1 16. The driving assist system as claimed in claim 13, wherein
2 the controller makes an operator response plan in response to
3 the determined future environment to determine a command
4 and generates the command; and further comprising an
5 accelerator reaction modulation actuator capable of modulating
6 reaction characteristic to manual effort applied onto an
7 accelerator of the vehicle by the operator in response to the
8 command.

17. The driving assist system as claimed in claim 13, wherein
the controller has various alert categories with different
environment categories and selects one of the alert categories

4 *for the determined future environment to determine a command,*
5 *and generates the command; and further comprising an alarm*
6 *capable of producing an alarm signal indicative of the selected*
7 *one alert category in response to the command.*

1 *18. The driving assist system as claimed in claim 15, wherein*
2 *the first risk category is a function of relative vehicle velocity and*
3 *vehicle separation.*

1 *19. The driving assist system as claimed in claim 15, wherein*
2 *the second risk category is a function of vehicle separation and*
3 *one of velocities of the vehicles.*

1 *20. The driving assist system as claimed in claim 15, wherein,*
2 *in determining future environment, the controller weighs the*
3 *first and second risk categories differently with first and second*
4 *parameters.*

1 *21. The driving assist system as claimed in claim 20, wherein*
2 *the second risk category is weighted less than the first risk*
3 *category is.*

1 *22. The driving assist system as claimed in claim 21, wherein*
2 *the determined future environment is the sum of the weighted*
3 *first and second risk categories.*

1 *23. The driving assist system as claimed in claim 21, wherein*
2 *the determined future environment is the greater one of the*
3 *weighted first and second risk categories.*

1 *24. A driving assist for assisting effort by an operator to*
2 *operate a vehicle in traveling, the driving assist system*
3 *comprising:*

4 *a data acquisition system acquiring data involving*
 5 *information on the presence of a leading vehicle in a field around*
 6 *the vehicle; and*
 7 *a controller, mounted to the vehicle, for receiving the*
 8 *acquired data, for determining an extent to which the vehicles*
 9 *has approached to each other, for determining a period of time*
 10 *as a function of the determined extent and for determining a*
 11 *future quantity of the extent that would occur upon elapse of the*
 12 *period of time from the determined extent to give future*
 13 *environment in the field.*

1 *25. The driving assist system as claimed in claim 24, wherein*
 2 *the controller makes an operator response plan in response to*
 3 *the determined future environment to determine a command*
 4 *and generates the command; and further comprising an*
 5 *accelerator reaction modulation actuator capable of modulating*
 6 *reaction characteristic to manual effort applied onto an*
 7 *accelerator of the vehicle by the operator in response to the*
 8 *command.*

1 *26. The driving assist system as claimed in claim 24, wherein*
 2 *the controller has various alert categories with different*
 3 *environment categories and selects one of the alert categories*
 4 *for the determined future environment to determine a command,*
 5 *and generates the command; and further comprising an alarm*
 6 *capable of producing an alarm signal indicative of the selected*
 7 *one alert category in response to the command.*

1 *27. The driving assist system as claimed in claim 24, wherein*
 2 *the period of time is inversely proportional to the determined*
 3 *extent.*

1 *28. The driving assist system as claimed in claim 15, wherein,*

2 in determining future environment, the controller calculates a
3 risk perceived (RP) as a function of the first and second risk
4 categories, and smoothes a difference between a change of the
5 RP with respect to a unit change in a time headway (THW)
6 between the vehicles when the time headway is less than a
7 threshold THW value and a change of the RP with respect to the
8 unit change in the time headway when the time headway is
9 greater than the threshold THW.

1 29. The driving assist system as claimed in claim 15,
2 wherein, when a time headway (THW) between the
3 vehicles is not greater than a threshold THW value, in
4 determining future environment, the controller calculates a risk
5 perceived (RP_0) as function of a first term, which is proportional
6 to the first risk category that is given by the reciprocal of a time
7 to contact (TTC) between the vehicles, and a second term, which
8 is proportional to the second risk category that is given by the
9 reciprocal of the THW;
10 and wherein, when the THW is greater than the threshold
11 THW value, in determining future environment, the controller
12 calculates a risk perceived (RP_1) as a function of the first term
13 and a third term, which is proportional to the second risk category
14 that is given by a quantity subtracted by the THW.

1 30. The driving assist system as claimed in claim 15,
2 wherein, in determining future traffic state, the controller
3 calculates a risk perceived (RP_2) as a function of a first term,
4 which is proportional to the first risk category that is given by the
5 reciprocal of a time to contact (TTC) between the vehicles, a
6 second term, which corresponds to the second risk category that
7 is given by the reciprocal of a time headway (THW) between the
8 vehicles, and a third term, which is proportional to the second
9 risk category that is given by a quantity subtracted by the THW;

10 *and wherein, the function involves a first parameter*
11 *multiplied with the second term and a second parameter*
12 *multiplied with the third term;*

13 *and wherein, the controller sets the first and second*
14 *parameters in response to the THW.*

1 *31. The driving assist system as claimed in claim 30, wherein*
2 *the controller sets the first and second parameters such that the*
3 *third term grows apparent in the function than the second term*
4 *does as the THW increases.*

1 *32. The driving assist system as claimed in claim 15, wherein,*
2 *in determining future environment, the controller calculates a*
3 *risk perceived (RP_2) as a function of a first term, which is*
4 *proportional to the first risk category that is given by the*
5 *reciprocal of a time to contact (TTC) between the vehicles, a*
6 *second term, which corresponds to the second risk category that*
7 *is given by the reciprocal of a time headway between the*
8 *vehicles, and a third term, which is proportional to the second*
9 *risk category that is given by a quantity subtracted by the THW;*
10 *and wherein, in response to the THW, the controller alters*
11 *weighting components, which are imposed on the second term*
12 *and the third term, respectively.*

1 *33. The driving assist system as claimed in claim 32, wherein,*
2 *when the THW is not greater than a threshold THW value, the*
3 *controller sets 1 as the weighting component imposed on the*
4 *second term and sets 0 as the weighting component imposed on*
5 *the third term; and, wherein, when the THW is greater than the*
6 *threshold THW value, the controller sets 0 as the weight*
7 *imposed on the second term and sets 1 as the weighting*
8 *components imposed on the third term.*

1 34. The driving assist system as claimed in claim 32, wherein,
2 when the THW is not greater than a threshold THW value, the
3 controller sets 1 as the weighting component imposed on the
4 second term and sets 0 as the weighting component imposed on
5 the third term; and wherein, as the THW exceeds the threshold
6 THW value, the controller alters the weighting components
7 imposed on the second term and the third term such that as the
8 THW increases, the weighting component imposed on the
9 second term ($1/THW$) reduces toward 0 from 1, while the
10 weighting component imposed on the third term increases from
11 0 toward 1.

1 35. The driving assist system as claimed in claim 28, wherein
2 the first risk category is a function of relative vehicle velocity and
3 vehicle separation.

1 36. The driving assist system as claimed in claim 28, wherein
2 the controller makes an operator response plan in response to
3 the determined future environment to determine a command
4 and generates the command; and further comprising an
5 accelerator reaction modulation actuator capable of modulating
6 reaction characteristic to manual effort applied onto an
7 accelerator of the vehicle by the operator in response to the
8 command.

1 37. The driving assist system as claimed in claim 28, wherein
2 the controller has various alert categories with different
3 environment categories and selects one of the alert categories
4 for the determined future environment to determine a command,
5 and generates the command; and further comprising an alarm
6 capable of producing an alarm signal indicative of the selected
7 one alert category in response to the command.

1 38. A driving assist system for assisting effort by an operator
2 to operate a vehicle in traveling, the driving assist system
3 comprising:

4 a data acquisition system acquiring data involving
5 information on the presence of an obstacle in a field around the
6 vehicle;

7 a controller, mounted to the vehicle, for receiving the
8 acquired data, for determining a risk which the obstacle would
9 cause the operator to perceive, for allocating commands for
10 prompting the operator to operating the vehicle longitudinally
11 and laterally, and for generating the commands; and

12 a plurality of actuators, mounted to the vehicle, to prompt
13 the operator in response to the commands to operating the
14 vehicle longitudinally and laterally.

1 39. The driving assist system as claimed in claim 38, wherein
2 the commands are applied to the plurality of actuators.

1 40. The driving assist system as claimed in claim 39, wherein
2 each of the plurality of actuators is capable of modulating
3 reaction characteristic to manual effort by the operator.

1 41. The driving assist system as claimed in claim 38, wherein
2 the data acquisition system is mounted to the vehicle.

1 42. The driving assist system as claimed in claim 38, wherein
2 the controller uses a direction from the vehicle to the obstacle, a
3 separation between the vehicle and the obstacle, and a relative
4 velocity between the vehicle and the obstacle in determining a
5 risk, which the obstacle would cause the operator to perceive.

1 43. The driving assist system as claimed in claim 42, wherein
2 the risk is a function of a time to contact (TTC) that is given by

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3 *dividing the separation by the relative velocity.*

1 *44. The driving assist system as claimed in claim 43, wherein*
 2 *the data acquisition system is mounted to the vehicle, and*
 3 *wherein the controller accounts for variance of the separation*
 4 *and variance of the relative velocity in determining the TTC.*

1 *45. The driving assist system as claimed in claim 44, wherein*
 2 *the obstacle is classified into one of predetermined categories;*
 3 *and wherein the variances of separation and relative velocity*
 4 *with regard to the obstacle are subject to variation, in magnitude,*
 5 *with different categories, which the obstacle may be classified*
 6 *into, of the predetermined categories.*

1 *46. The driving assist system as claimed in claim 44, wherein*
 2 *the data acquisition system includes a plurality sensors of*
 3 *different kinds, in performance, for sensing the obstacle; and*
 4 *wherein the variances of separation and relative velocity with*
 5 *regard to the obstacle are subject to variation, in magnitude,*
 6 *with different kinds, in performance, of sensors, whereby the*
 7 *obstacle may be sensed.*

1 47. The driving assist system as claimed in claim 43, wherein
2 the obstacle is classified into one of predetermined categories
3 that are weighted differently, and wherein the controller
4 accounts for how much the category, which the obstacle is
5 classified into, is weighted in determining the TTC that is used in
6 determining the risk.

1 48. The driving assist system as claimed in claim 44, wherein
2 the obstacle is classified into one of predetermined categories
3 that are weighted differently, and wherein the controller
4 accounts for how much the category, which the obstacle is
5 classified into, is weighted in determining the TTC that is used in
6 determining the risk.

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1 49. The driving assist system as claimed in claim 46, wherein
2 the obstacle is classified into one of predetermined categories
3 that are weighted differently, and wherein the controller
4 accounts for how much the category, which the obstacle is
5 classified into, is weighted in determining the TTC that is used in
6 determining the risk.

1 50. The driving assist system as claimed in claim 45, wherein
2 the obstacle is classified into one of predetermined categories
3 that are weighted differently, and wherein the controller
4 accounts for how much the category, which the obstacle is
5 classified into, is weighted in determining the TTC that is used in
6 determining the risk.

1 51. The driving assist system as claimed in claim 42, wherein,
2 in making an operator response plan, the controller divides the
3 determined risk into a longitudinal, with respect to the vehicle,
4 risk component and a lateral, with respect to the vehicle, risk
5 component, uses the longitudinal risk component to determine

6 *the amount of input to one of the plurality of actuators, and uses*
7 *the lateral risk component to determine the amount of input to*
8 *another of the plurality of actuators.*

1 *52. The driving assist system as claimed in claim 42, wherein,*
2 *in making an operator response plan, the controller estimates a*
3 *change in the risk for a change of manual effort by the operator*
4 *in operating the vehicle longitudinally and a change of manual*
5 *effort by the operator in operating the vehicle laterally.*

1 *53. A driving assist system for assisting effort by an operator*
2 *to operate a vehicle in traveling, the driving assist system*
3 *comprising:*

4 *a data acquisition system acquiring data involving*
5 *information on the presence of obstacles in a field around the*
6 *vehicle;*

7 *a controller, mounted to the vehicle, for receiving the*
8 *acquired data, for determining a risk which each of the obstacles*
9 *would cause the operator to perceive, for making an operator*
10 *response plan in response to the risks, which plan prompts the*
11 *operator to operating the vehicle longitudinally and laterally, to*
12 *determine commands, and for generating the commands; and*

13 *a plurality of actuators, mounted to the vehicle, to prompt*
14 *the operator in response to the commands to operating the*
15 *vehicle longitudinally and laterally.*

1 *54. The driving assist system as claimed in claim 38, wherein*
2 *one of the plurality of actuators is capable of modulating reaction*
3 *characteristic to manual effort applied onto an accelerator of the*
4 *vehicle by the operator.*

1 *55. The driving assist system as claimed in claim 38, wherein*
2 *one of the plurality of actuators is capable of modulating reaction*

3 *characteristic to manual effort applied onto a brake of the*
4 *vehicle by the operator.*

1 *56. The driving assist system as claimed in claim 38, wherein*
2 *one of the plurality of actuators is capable of modulating reaction*
3 *characteristic to manual steering effort by the operator.*

1 *57. A driving assist system for assisting effort by an operator*
2 *to operate a vehicle in traveling, the driving assist system*
3 *comprising:*
4 *a data acquisition system, mounted to the vehicle,*
5 *acquiring data involving information on the presence of an*
6 *obstacle in a field around the vehicle;*
7 *a controller, mounted to the vehicle, for receiving the*
8 *acquired data, for determining a risk which the obstacle would*
9 *cause the operator to perceive using a direction from the vehicle*
10 *to the obstacle, a separation between the vehicle and the*
11 *obstacle, and a relative velocity between the vehicle and the*
12 *obstacle, for allocating commands for prompting the operator to*
13 *operating the vehicle longitudinally and laterally, and for*
14 *generating the commands; and*
15 *a plurality of actuators, mounted to the vehicle, to prompt*
16 *the operator in response to the commands to operating the*
17 *vehicle longitudinally and laterally,*
18 *the plurality of actuators including an accelerator reaction*
19 *modulation actuator capable of modulating reaction*
20 *characteristic to manual effort applied onto an accelerator of the*
21 *vehicle by the operator, a brake pedal reaction modulation*
22 *actuator capable of modulating reaction characteristic to manual*
23 *effort applied onto a brake of the vehicle by the operator, and a*
24 *steering reaction modulation actuator capable of modulating*
25 *reaction characteristic to manual steering effort by the operator.*

1 58. A driving assist system for assisting effort by an operator
2 to operate a vehicle in traveling, the driving assist system
3 comprising:

4 a data acquisition system, mounted to the vehicle,
5 acquiring data involving information on the presence of
6 obstacles in a field around the vehicle;

7 a controller, mounted to the vehicle, for receiving the
8 acquired data, for determining a risk which each the obstacles
9 would cause the operator to perceive using a direction from the
10 vehicle to the obstacle, a separation between the vehicle and the
11 obstacle, and a relative velocity between the vehicle and the
12 obstacle, for making an operator response plan in response to
13 the risk, which plan prompts the operator to operating the
14 vehicle longitudinally and laterally, to determine commands, and
15 for generating the commands; and

16 a plurality of actuators, mounted to the vehicle, to prompt
17 the operator in response to the commands to operating the
18 vehicle longitudinally and laterally,

19 wherein, in making an operator response plan, the
20 controller divides each the determined risks into a longitudinal,
21 with respect to the vehicle, risk component and a lateral, with
22 respect to the vehicle, risk component, uses the total of the
23 longitudinal risk components to determine the amount of input
24 to one of the plurality of actuators, and uses the total of the
25 lateral risk components to determine the amount of input to
26 another of the plurality of actuators.

1 59. The driving assist system as claimed in claim 58, wherein
2 the risk which each the obstacles would cause the operator to
3 perceive is a function of a time to contact (TTC) between the
4 vehicle and the obstacle.

1 60. A driving assist system for assisting effort by an operator

2 to operate a vehicle in traveling, the driving assist system
3 comprising:

4 means for acquiring data involving information on the
5 presence of obstacles in a field around the vehicle;

6 means for determining a risk which each the obstacles
7 would cause the operator to perceive using a direction from the
8 vehicle to the obstacle, a separation between the vehicle and the
9 obstacle, and a relative velocity between the vehicle and the
10 obstacle

11 means for dividing each the determined risks into a
12 longitudinal, with respect to the vehicle, risk component and a
13 lateral, with respect to the vehicle, risk component;

14 means for calculating the total of the longitudinal risk
15 components and the total of the lateral risk components;

16 means for making an operator response plan in response
17 to the calculated totals, which plan prompts the operator to
18 operating the vehicle longitudinally and laterally, to determine
19 commands; and

20 means for prompting the operator in response to the
21 commands to operating the vehicle longitudinally and laterally.

1 61. A vehicle operated by an operator in traveling, the vehicle
2 comprising:

3 a data acquisition system acquiring data including
4 information on vehicle state and information on environment in
5 a field around the vehicle;

6 a controller for determining future environment in the field
7 using the acquired data, for making an operator response plan in
8 response to the determined future environment, which plan
9 prompts the operator to operating the vehicle in a desired
10 manner for the determined future environment, to determine
11 command, and for generating the command; and

12 at least one actuator for prompting the operator in

13 *response to the command to operating the vehicle in the desired*
14 *manner.*

1 *62. A vehicle operated by an operator in traveling, the vehicle*
2 *comprising:*

3 *a data acquisition system acquiring data including*
4 *information on vehicle state and information on environment in*
5 *a field around the vehicle, the information on environment*
6 *involving information on the presence of obstacles in the field;*

7 *a controller for receiving the acquired data, for*
8 *determining future environment in the field, the determined*
9 *future environment involving a risk which each of the obstacles*
10 *would cause the operator to perceive, for making an operator*
11 *response plan in response to the determined future environment,*
12 *which plan prompts the operator to operating the vehicle at least*
13 *longitudinally to reduce the risks, to determine commands, and*
14 *for generating the commands; and*

15 *a plurality of actuators for promoting the operator in*
16 *response to the commands to operating the vehicle at least*
17 *longitudinally, the plurality of actuators includes an accelerator*
18 *reaction modulation actuator capable of modulating reaction*
19 *characteristic to manual effort applied onto an accelerator of the*
20 *vehicle.*

1 *63. A vehicle operated by an operator in traveling, the vehicle*
2 *comprising:*

3 *a data acquisition system acquiring data involving*
4 *information on the presence of an obstacle in a field around the*
5 *vehicle;*

6 *a controller for receiving the acquired data, for*
7 *determining a risk which the obstacle would cause the operator*
8 *to perceive, for allocating commands for prompting the operator*
9 *to operating the vehicle longitudinally and laterally, and for*

10 *generating the commands; and*
11 *a plurality of actuators, mounted to the vehicle, to prompt*
12 *the operator in response to the commands to operating the*
13 *vehicle longitudinally and laterally.*

1 *64. A vehicle operated by an operator in traveling, the vehicle*
2 *comprising:*
3 *a data acquisition system acquiring data involving*
4 *information on the presence of obstacles in a field around the*
5 *vehicle;*
6 *a controller for receiving the acquired data, for*
7 *determining a risk which each of the obstacles would cause the*
8 *operator to perceive, for making an operator response plan in*
9 *response to the risks, which plan prompts the operator to*
10 *operating the vehicle longitudinally and laterally, to determine*
11 *commands, and for generating the commands; and*
12 *a plurality of actuators to prompt the operator in response*
13 *to the commands to operating the vehicle longitudinally and*
14 *laterally.*

1 *65. A vehicle operated by an operator in traveling, the vehicle*
2 *comprising:*
3 *a data acquisition system acquiring data involving*
4 *information on the presence of an obstacle in a field around the*
5 *vehicle;*
6 *a controller for receiving the acquired data, for*
7 *determining a risk which the obstacle would cause the operator*
8 *to perceive using a direction from the vehicle to the obstacle, a*
9 *separation between the vehicle and the obstacle, and a relative*
10 *velocity between the vehicle and the obstacle, for making an*
11 *operator response plan in response to the risk, which plan*
12 *prompts the operator to operating the vehicle longitudinally and*
13 *laterally, to determine commands, and for generating the*

14 *commands; and*

15 *a plurality of actuators to prompt the operator in response*
16 *to the commands to operating the vehicle longitudinally and*
17 *laterally,*

18 *the plurality of actuators including an accelerator reaction*
19 *modulation actuator capable of modulating reaction*
20 *characteristic to manual effort applied onto an accelerator of the*
21 *vehicle by the operator, a brake pedal reaction modulation*
22 *actuator capable of modulating reaction characteristic to manual*
23 *effort applied onto a brake of the vehicle by the operator, and a*
24 *steering reaction modulation actuator capable of modulating*
25 *reaction characteristic to manual steering effort by the operator.*

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1 66. *A vehicle operated by an operator in traveling, the vehicle*
2 *comprising:*

3 *a data acquisition system acquiring data involving*
4 *information on the presence of obstacles in a field around the*
5 *vehicle;*

6 *a controller for receiving the acquired data, for*
7 *determining a risk which each the obstacles would cause the*
8 *operator to perceive using a direction from the vehicle to the*
9 *obstacle, a separation between the vehicle and the obstacle, and*
10 *a relative velocity between the vehicle and the obstacle, for*
11 *making an operator response plan in response to the risk, which*
12 *plan prompts the operator to operating the vehicle longitudinally*
13 *and laterally, to determine commands, and for generating the*
14 *commands; and*

15 *a plurality of actuators to prompt the operator in response*
16 *to the commands to operating the vehicle longitudinally and*
17 *laterally,*

18 *wherein, in making an operator response plan, the*
19 *controller divides each the determined risks into a longitudinal,*
20 *with respect to the vehicle, risk component and a lateral, with*

21 *respect to the vehicle, risk component, uses the total of the*
22 *longitudinal risk components to determine the amount of input*
23 *to one of the plurality of actuators, and uses the total of the*
24 *lateral risk components to determine the amount of input to*
25 *another of the plurality of actuators.*

1 *67. A method for assisting effort by an operator to operate a*
2 *vehicle in traveling, the method comprising:*
3 *acquiring data including information on vehicle state and*
4 *information on environment in a field around the vehicle;*
5 *determining future environment in the field using the*
6 *acquired data;*
7 *making an operator response plan in response to the*
8 *determined future environment, which plan prompts the*
9 *operator to operating the vehicle in a desired manner for the*
10 *determined future environment, to determine command; and*
11 *prompting the operator in response to the command to*
12 *operating the vehicle in the desired manner.*

1 *68. A method for assisting effort by an operator to operate a*
2 *vehicle in traveling, the method comprising:*
3 *acquiring data including information on vehicle state and*
4 *information on environment in a field around the vehicle, the*
5 *information on environment involving information on the*
6 *presence of obstacles in the field;*
7 *determining future environment in the field based on the*
8 *acquired data, the determined future environment involving a*
9 *risk which each of the obstacles would cause the operator to*
10 *perceive;*
11 *making an operator response plan in response to the*
12 *determined future environment, which plan prompts the*
13 *operator to operating the vehicle at least longitudinally to reduce*
14 *the risks, to determine commands; and*

15 *prompting the operator in response to the commands to*
16 *operating the vehicle at least longitudinally, by modulating*
17 *reaction characteristic to manual effort applied onto an*
18 *accelerator of the vehicle.*

1 69. *A method for assisting effort by an operator to operate a*
2 *vehicle in traveling, the method comprising:*
3 *acquiring data involving information on the presence of a*
4 *leading vehicle in a field around the vehicle; and*
5 *determining, based on the acquired data, a reciprocal of a*
6 *time to contact (TTC) between the vehicles;*
7 *determining, based on the acquired data a reciprocal of a*
8 *time headway (THW) between the vehicles;*
9 *determining future environment in the field based on the*
10 *determined reciprocals;*
11 *making an operator response plan in response to the*
12 *determined future environment to determine a command; and*
13 *modulating reaction characteristic to manual effort*
14 *applied onto an accelerator of the vehicle in response to the*
15 *command.*

1 70. *A method for assisting effort by an operator to operate a*
2 *vehicle in traveling, the method comprising:*
3 *acquiring data involving information on the presence of a*
4 *leading vehicle in a field around the vehicle; and*
5 *determining, based on the acquired data, an extent to*
6 *which the vehicles has approached to each other;*
7 *determining a period of time as a function of the*
8 *determined extent;*
9 *determining a future quantity of the extent that would*
10 *occur upon elapse of the period of time from the determined*
11 *extent to give future environment in the field;*
12 *making an operator response plan in response to the*

13 *determined future environment to determine a command; and*
14 *modulating reaction characteristic to manual effort*
15 *applied onto an accelerator of the vehicle by the operator in*
16 *response to the command.*

1 *71. A method for assisting effort by an operator to operate a*
2 *vehicle in traveling, the method comprising:*
3 *acquiring data involving information on the presence of an*
4 *obstacle in a field around the vehicle;*
5 *determining, out of the acquired data, a risk which the*
6 *obstacle would cause the operator to perceive;*
7 *allocating commands for prompting the operator to*
8 *operating the vehicle longitudinally and laterally; and*
9 *prompting the operator in response to the commands to*
10 *operating the vehicle longitudinally and laterally.*

1 *72. A method for assisting effort by an operator to operate a*
2 *vehicle in traveling, the method comprising:*
3 *acquiring data involving information on the presence of*
4 *obstacles in a field around the vehicle;*
5 *determining, out of the acquired data, a risk which each of*
6 *the obstacles would cause the operator to perceive;*
7 *making an operator response plan in response to the risks,*
8 *which plan prompts the operator to operating the vehicle*
9 *longitudinally and laterally, to determine commands; and*
10 *prompting the operator in response to the commands to*
11 *operating the vehicle longitudinally and laterally.*

1 *73. A method for assisting effort by an operator to operate a*
2 *vehicle in traveling, the method comprising:*
3 *acquiring data involving information on the presence of*
4 *obstacles in a field around the vehicle;*
5 *determining, out of the acquired data, a risk which each of*

6 the obstacles would cause the operator to perceive using a
7 direction from the vehicle to the obstacle, a separation between
8 the vehicle and the obstacle, and a relative velocity between the
9 vehicle and the obstacle;

10 making an operator response plan in response to the risks,
11 which plan prompts the operator to operating the vehicle
12 longitudinally and laterally, to determine commands;

13 modulating reaction characteristic to manual effort
14 applied onto an accelerator of the vehicle by the operator in
15 response to one of the commands;

16 modulating reaction characteristic to manual effort
17 applied onto a brake of the vehicle by the operator in response to
18 another of the commands; and

19 modulating reaction characteristic to manual steering
20 effort by the operator in response to other of the commands.

1 74. The method as claimed in claim 73, wherein the step of
2 making an operator response plan comprises the sub-steps of:

3 dividing each the determined risks into a longitudinal, with
4 respect to the vehicle, risk component and a lateral, with respect
5 to the vehicle, risk component; and

6 calculating the total of the longitudinal risk components
7 and the total of the lateral risk components in determining the
8 commands.

1 75. A system for assisting effort by an operator to operate a
2 vehicle in traveling, the system comprising:

3 means for acquiring data including information on vehicle
4 state and information on environment in a field around the
5 vehicle;

6 means for determining future environment in the field
7 using the acquired data;

8 means for making an operator response plan in response

9 to the determined future environment, which plan prompts the
10 operator to operating the vehicle in a desired manner for the
11 determined future environment, to determine command; and
12 means for prompting the operator in response to the
13 command to operating the vehicle in the desired manner.

1 76. A vehicle operated by an operator in traveling, the vehicle
2 comprising:
3 means for acquiring data including information on vehicle
4 state and information on environment in a field around the
5 vehicle;
6 means for determining future environment in the field
7 using the acquired data;
8 means for making an operator response plan in response
9 to the determined future environment, which plan prompts the
10 operator to operating the vehicle in a desired manner for the
11 determined future environment, to determine command; and
12 means for prompting the operator in response to the
13 command to operating the vehicle in the desired manner.